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ABSTRACT

This environmental unit is one of a series designed for integration within an existing curriculum. The unit is self-contained and requires minimal teacher preparation. The philosophy of the units is based on an experience-oriented process that encourages self-paced independent student work. The purpose of this unit is to familiarize students with the structural organization, or pattern, of natural objects. Specifically, the students study the structure of tree or shrub brances that they have collected. Students exchange branches and keep their data recorded in a branch booklet. The duplicating masters for the booklet are included in the materials. After the students have studied a variety of branches, they try to reconstruct a branch that has been divided into the parts of a plant puzzle. Additional activities include counting annual rings of trees, observing buds, and rooting branches. The activities are geared for students in grades 1-6. A list of materials needed, directions, and background information are included for the teacher. (MA)

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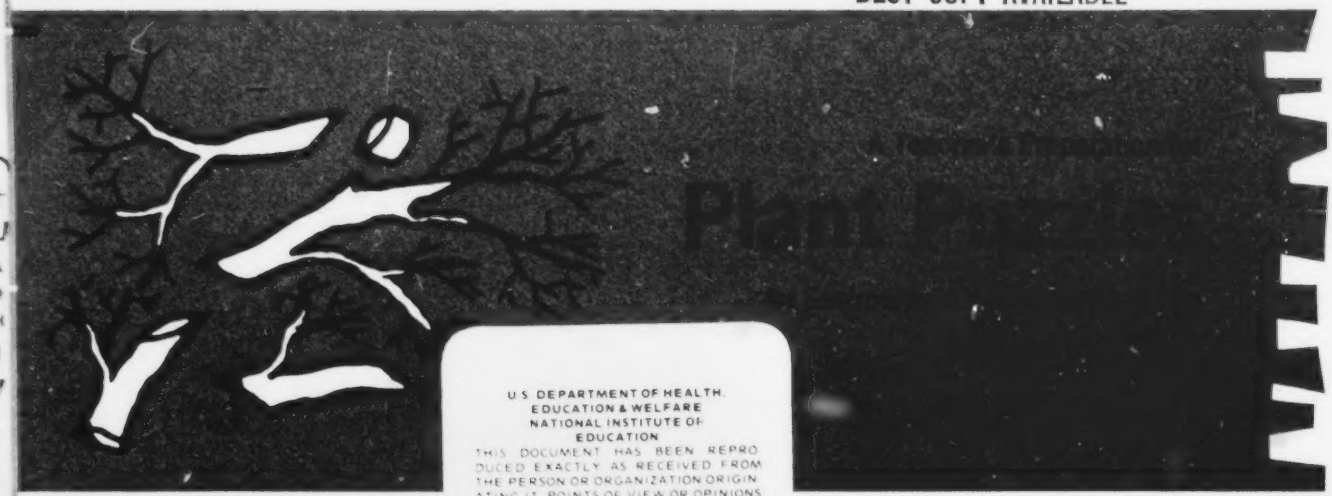

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MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.

THE ENVIRONMENTAL UNITS

This is one of a group of Environmental Units written by the Environmental Science Center and published by the National Wildlife Federation.

In both theory and practice education is the essential base for long-range local, regional and national programs to improve and maintain the quality of environment necessary for man's welfare and survival. Citizens must be aware of ecological relationships in order to recognize, appreciate and fulfill constructive roles in society. This awareness should be launched through the existing educational process—in classroom and related school activities. No special courses on ecology can replace the need to integrate ecological learning throughout the existing curricula of our school systems. Furthermore, the life-styles and value-systems necessary for rational environmental decisions can best be acquired through repeated exposure to ecological learning which pervades the total educational experience.

It was with these thoughts that we developed these curriculum materials. They were designed for the classroom teacher to use with a minimal amount of preparation. They are meant to be part of the existing curriculum—to complement and enhance what students are already experiencing. Each unit is complete in itself, containing easy-to-follow descriptions of objectives and methods, as well as lists of simple materials.

The underlying philosophy throughout these units is that learning about the environment is not a memorization process, but rather an experience-oriented, experiment-observation-conclusion sort of learning. We are confident that students at all levels will arrive at intelligent ecological conclusions if given the proper opportunities to do so, and if not forced into "right" answers and precisely "accurate" names for their observations. If followed in principle by the teacher, these units will result in meaningful environmental education.

In the process of development, these units have been used and tested by classroom teachers, after which they have undergone evaluations, revisions and adaptations. Further constructive comments from classroom teachers are encouraged in the hope that we may make even more improvements.

A list of units in this group appears on the inside back cover.

About the National Wildlife Federation—1412 Sixteenth Street, N.W., Washington, D.C. 20036

Founded in 1936, the National Wildlife Federation has the largest membership of any conservation organization in the world and has affiliated groups in each of the 50 states, Guam, and the Virgin Islands. It is a non-profit, non-governmental organization devoted to the improvement of the environment and proper use of all natural resources. NWF distributes almost one million copies of free and inexpensive educational materials each year to youngsters, educators and concerned citizens. Educational activities are financed through contributions for Wildlife Conservation Stamps.

About the Environmental Science Center--5400 Glenwood Avenue, Minneapolis, Minnesota 55422

The Environmental Science Center, established in 1967 under Title III of the Elementary and Secondary Education Act is now the environmental education unit of the Minnesota Environmental Sciences Foundation, Inc. The Center works toward the establishment of environmental equilibrium through education—education in a fashion that will develop a conscience which guides man in making rational judgments regarding the environmental consequences of his actions. To this end the Environmental Science Center is continuing to develop and test a wide variety of instructional materials and programs for adults who work with youngsters.

Plant Puzzles

An Environmental Investigation

BY

NATIONAL WILDLIFE FEDERATION

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.

Designed and Illustrated by
JAN BLYLER

A jigsaw puzzle is a complete picture that has been cut up into pieces. The picture has a pattern. It might be one of blue sky and barn and green grass and lake in the distance. We can use the pattern or the organization of the picture, as well as the shape of the interlocking pieces, to help put the picture back together. Recognizing the pattern of the picture makes the reconstruction easier.

All *natural* objects also reflect a pattern or structural organization. The objects themselves can be thought of as complete entities made up of parts. The parts might be seen as pieces in a natural puzzle. Together these parts form an organized and somewhat predictable system.

This unit aims to help children become more familiar with some of the characterizing patterns of natural objects. By learning more about patterns in a particular object, the children should come to a better understanding of the object itself. Then, that object, whether it be a leaf, a tree, a flower, a snowflake or whatever—might begin to stand out like a friend from the background of all other things in the universe.

This unit is meant to be fun. Our hope is that in learning about what goes on around them—the contents and the workings of nature—children will appreciate their environment that much more and will want to protect it.

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INTRODUCTION

Plant Puzzles aims to familiarize children with patterns in nature. To accomplish this, children will inspect a number of branches. They will examine the external structures and characteristics, as well as the internal pattern of the stem. Through these activities, some of the relationships between external characteristics and internal patterns will become apparent. For example, the children will see that a branch causes an interruption or variation in the internal pattern of the stem; or, that the number of rings in cross-sections of a woody stem decreases from the bottom to the top.

The children will examine external characteristics of their branches such as the buds, leaf scars, the bark color and texture, pores in the bark, and leaves. *Buds*, for example, are found at the point of leaf and stem junctions and are the forerunners of branches, leaves, and flowers. *Bark* is essentially a protective covering for a plant. Because the bark is relatively impermeable, *pores* are formed for the passage of gases to and from the living tissue within. The pores are especially conspicuous on smooth-barked branches, and appear as tiny, hard "pimples."

The internal pattern of the branch will be revealed by cutting the branch with pruning shears. The ring pattern found in the cross-section of a branch is formed from different types of tissue which provide support and serve to conduct plant nutrients up and down the stem—out into the branches, leaves, buds, and flowers and down to the roots. Usually one ring is added for each year of growth.

During the activities of this unit, each child will make a puzzle out of a branch. After exchanging their plant puzzles, the children will try to reconstruct their classmates' branches, using knowledge gained through observation of branch structure and patterns.

All the activities and the natural items discussed in this unit are intended to be suggestions. We hope you will use the unit as a starting point for further investigations into other patterns which Nature offers.

MATERIALS

pruning shears (1 to 6)
quart milk cartons (one per child)
large cardboard box—
T.V. carton, etc. (one)
cardboard string tags
(several per child)
water
shallow cardboard boxes
(large enough so that each will hold several milk cartons)
rubber bands (one box)
tape
tape recorder amplifier (optional)
handsaw

Plant Puzzles

Collecting the Small Branches

If these activities are started in March or early April the children will be able to see leaves and flowers appear from buds on the branches they collect.

Ask each child to bring *two* branches from home. These branches each should: (1) be as long as his arm; (2) come from the same tree or bush; and (3) be "interesting." The word "interesting" is mentioned to help insure that you will have branches from a number of different kinds of trees. Variety is desirable.

You might duplicate and send home the note on page 16 for the parents so they are aware of what their children will be doing and may assist them in getting the branches.

When the children have brought their branches to school, have each of them select *one* branch to watch bloom or leaf out. Each child might put a piece of tape around the top of this one branch he wants to save, to distinguish it from the other branch. The other branch will be handled a lot and may be injured. Eventually it will be cut up.

Each child can put both of his branches in his quart milk carton. The milk cartons should be numbered consecutively. Give each child two name tags —one for each of his branches. The tags should be about three inches square. On one side of both tags, have each child write his name. On the other side of both tags, have each child write the number of his milk carton. The number should be large enough so it can be seen across the room. (This will be needed in a later section of the unit.)

The milk cartons can be placed in rows in large cardboard boxes so they don't tip over. During those times when the branches are not being investigated they should be kept in the boxes near a window, in order to receive sunlight. Keep a little water in each carton.

The leafing-out branches—those with tape—can be left in the cartons throughout all the activities of this unit. During the days ahead, have each child make periodic checks of his leafing-out branch. He can compare its buds (and any changes he may notice) with the buds of his other branch. If each child keeps a chart of the changes he detects, he will have a permanent record of his branch's development.

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WATCHING A BRANCH LEAF-OUT

Date April 15
Observations Buds appear more swollen today than yesterday, scales around buds still closed.
Date April 16
Observations scales are beginning to open; when cut, shows a small branch-like shoot
Date April 17
Observations some leaves are beginning to appear
Date April 18
Observations leaves are continuing to come out, those out first are longer

Observing Small Branches in the Classroom

I. What Branch Am I Thinking Of?

A. Have each child remove from his milk carton his branch without tape and lay it on his desk where it can be seen easily.

B. Walk around the room and make a mental note of one of the branches. Without pointing or telling the children which branch you are thinking of, describe some of its easily noticeable characteristics. Describe such things as color of bark, size, color, or formation of the buds, size of the branch, etc. You might mention such things as whether the buds are hairy, sharp, or otherwise; how the smaller branches are arranged on the main branch; how many buds there are and the position of the buds.

C. Have the children try to guess whose branch you are thinking of.

This activity starts the children looking at the obvious outward appearance of their branches.

II. What Do the Branches Look Like?

A. The back of the book contains several pages which will comprise a booklet for the children. Duplicate these pages and make them into booklets. Pass out one booklet to each child. The children should fill in the charts and drawings by examining their own branches. The booklet pages have the following directions:

Page 1—Type of Buds (three sketches)
Circle the bud which looks most like the bud on the end of your branch. Draw a picture of the bud at the end of your branch.

Arrangements of Buds (three sketches)
Circle the branch which has an arrangement of buds most like the arrangement on your branch.

Page 2—Leaf Scars (five sketches)
Circle the leaf scar that looks most like the leaf scars on your branch. Draw a picture of one of the leaf scars on your branch.

Page 3—1. Do this page when leaves come out of the buds on your branch.
2. Take a leaf from your branch and trace around it, making an outline of the leaf.
3. Look at the leaf closely. What do you see? Draw what you see inside the outline of the leaf.

Page 4—Make a drawing of your branch on this page. First tape the branch to the top of your desk so it will not move. Draw just the side of the branch that faces you.

B. Have each child check the first three pages of several other booklets by exchanging booklets and branches. (This will expose all the children to a variety of branches.) If a child disagrees with an answer in a booklet, he should discuss it with the owner. He can initial each booklet he checks.

III. Finding the Bottom Piece of the Branch

A. Using the pruning shears, cut one inch off the bottom of each child's branch (use the branch without the tape.) Collect the pieces in a box.
B. Have the children gather around a table.
C. Spill the end pieces from the box onto the table. (It is usually quite a surprise to see the variety of bark colors in such a display.)
D. Have the children see if they can retrieve the piece taken from their branch. (They may have to refer to their branch and try to match it up with one of the end pieces.)

E. Can each end piece be fitted onto its respective branch exactly as it was before being cut away?

This activity emphasizes the bark color. As the children try to match the cut ends they will also have to look more closely at other characteristics of the bark (markings, etc.) and possibly at the ring pattern exposed by the cut.

IV. Making a Radio Broadcast

A. Remove the bottom and one side of the cardboard box and place it at the front of the room with the open side facing away from the students. The box should be large enough so that a bucket containing one of each child's branches can be placed inside.
B. Place a tape recorder amplifier in front of the box so that the sound will be directed to the students in the classroom. The microphone should be on the opposite or open side of the box. The box and amplifier are the broadcast station.
C. Gather up all of the branches that the children have been using in the previous activities. (These are the branches that do not have the tape on them.) Put all of these branches into one single bucket with water and place the bucket inside the cardboard box so that the branches cannot be seen by members of the class.
D. Take the individual milk cartons which all still contain one branch each and place them around the room in various locations. Arrange them so all the children can see all the branches and numbers easily.
E. Have one child get behind the cardboard box or broadcast station. Have this child take one branch from the container inside the station (not necessarily his own branch) and describe it over the loudspeaker. He should hold the branch so his classmates cannot see it. By this time, he should be familiar with many characteristics he could describe. For example, he might recall the charts he filled out and describe the buds, the branching pattern, etc. He might mention whether the bud is sharp, hairy, etc. The words he uses should be his own.
F. As soon as a child in the audience feels he knows which branch is being described, he should raise his hand and give the number of that branch. If the child is correct, he gets to broadcast a description of a branch. If he is incorrect, the original broadcaster continues.

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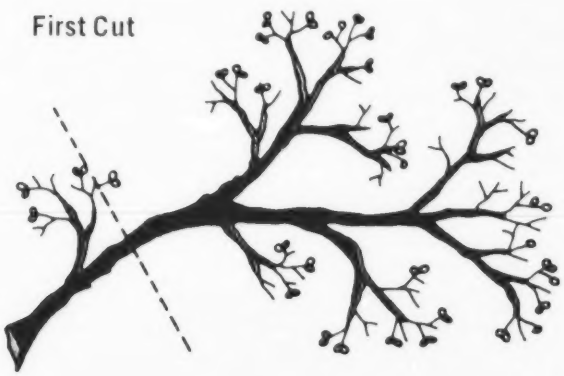
V. Making a Plant Puzzle

MATERIALS

pruning shears *paper*
branches *name tags*
rubberbands

A. Have the children predict what they think the cross-section of a branch will look like when it is cut like this:

First Cut



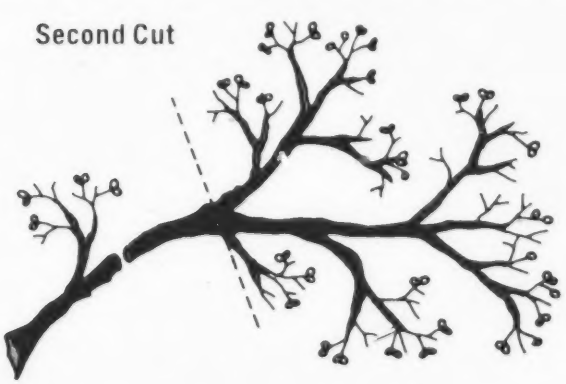
Have each child make a circle and inside the circle have each draw what he thinks the branch cross-section will look like. He should label the drawing "imaginary."

B. As each child finishes his drawing, he should raise his hand and have you cut his branch with the pruning shears. (Use the branch without the tape.)

C. Have him draw what it actually looks like now that he can see it. He should label this drawing "real" and compare it with the "imaginary" drawing.

D. Now, have each child predict what he thinks the branch will look like when cut like this:

Second Cut



He should make a drawing of his prediction, labeling this drawing "imaginary."

E. As each student finishes his drawing, again cut his branch and have him make a drawing of what the cross-section actually looks like. Have the children label their drawings "real" and compare them with the "imaginary" ones.

F. Have them select *three* more spots they would like to cut across and examine. (If you have extra pruning shears you might have some children help make these cuts.)

G. Pass out rubber bands. Each child can fasten a name tag to the rubber band and gather the five pieces of his branch together with the rubber band. This is his **plant puzzle.**

H. Ask the children to exchange puzzles with each other and see if they can reconstruct the branches. If they have trouble they should get help from the student who made the puzzle.

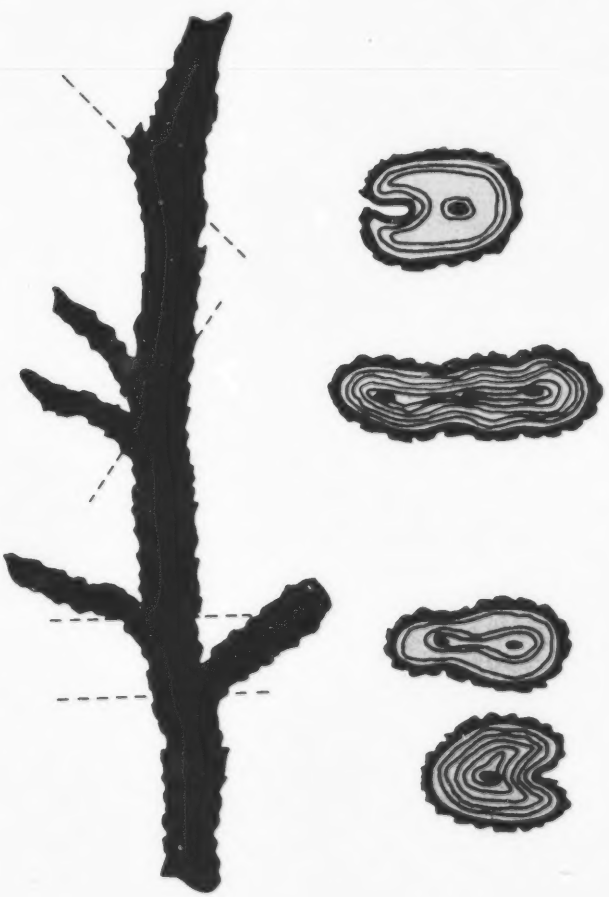
This activity starts the children looking at internal characteristics and patterns and how these patterns change in relation to the external characteristics they have been studying.

Observing Big Branches

A. Get some large branches. These can be obtained from commercial tree trimmers or you might gather them yourself from a wooded area

in the country. Try to get a variety of types. If you trim the branches yourself, you will want to put a tree-coating material over the places where the cuts are made. These branches will be used to make more plant puzzles.

B. Using a handsaw, cut the branches into pieces about one to two feet in length. Have no more than four or five pieces to a puzzle. If the branch is quite large you can make a couple of puzzles from it. Small, full branches might be trimmed and the trimmings discarded. In sectioning a branch to make the puzzle, make most of your cuts across points where side branches leave the main one or where injuries or growths are noticed. The pattern of the ring structure in these areas will be interesting and unusual.



C. Put the pieces from each puzzle in a bag. Assign one bag to each pair of children. (If you have made only a couple of puzzles, you might handle them as an individual activity where a child puts the puzzle together during his free time.)

D. Have them reconstruct the branch or tree. If you have made several puzzles from a single branch, they should find the other puzzles from their branch and join them together to form the complete branch.

E. Discuss the varying internal patterns the children found. Can they tell why the pattern is so different in a spot where a branch has formed when compared with a spot where there is no branch?

F. Have the groups exchange puzzles. What comparisons can be made between internal patterns of different types of trees?

Duplicate the next four pages to form the booklets for the children.

BRANCH BOOKLET

Have several of your classmates initial your booklet after they have checked it.

Circle the bud which looks most like the bud on the end of your branch. Circle the branch which has an *arrangement* of buds most like the arrangement on your branch. Draw a picture of the bud at the end of your branch, in the box at the right.

Circle the *leaf scar* that looks most like the leaf scars on your branch.
Draw a picture of one of the leaf scars on your branch, in the box at the right.

1. Do this page when leaves come out of the buds on your branch.
2. Take a leaf from your branch and trace around it, making an outline of the leaf.
3. Look at the leaf closely. What do you see? Draw what you see inside the outline of the leaf.

Make a drawing of your branch on this page. First tape the branch to the top of your desk so it will not move. Draw just the side of the branch that faces you.

Additional Activities

I. Rooting of Branches

The branches of some trees and bushes will take root when they are cut and placed in water. If you would like to observe this, have the students begin the activity in early spring, after the hard freezing of winter but before the buds have started to open.

Not all kinds of plants will root. This activity, then, can be a comparative one in which the children try to discover the *kinds* of plants that will root from the twigs of branches.

About a 1- or 2-foot section of branch should be cut off, the lower twigs or sub-branches trimmed, and the branch placed into a vase or can of water. If this is set near a cool window of the school, the twig buds, and then perhaps some flower buds, will open. After this has happened, and sometimes even after these buds have dropped off, the roots will start to appear as white fuzzy or white dendritic growths under the water along the branch. Such trees as willow, poplar, some shrubs, and dogwood will develop roots of this sort.

II. Where Do the Trees Branch?

Different kinds of trees and bushes have different branching patterns, and even in winter time it is possible to recognize trees from their shapes. The students might find it interesting to photograph the silhouette pattern of trees against the sky or to reproduce drawings and see if they can distinguish between the various branching patterns. Some trees branch high up off the ground; others start branching close to the ground. Some have branches that droop; others that turn up; others have branches that spread sideways. Several bushes and shrubs have many vertical branches or stems which start from the ground, whereas trees, of course, have only one main stem.

Studying the shapes of trees and observing their natural silhouettes can be quite interesting. Tree design might be worked into a good art project with various tree shapes serving as components of an artistic design. While doing activities of this sort, you might want to ask the class what influences they think can change the pattern of tree growth (such as trimming, shade, buildings, wind, etc.)

III. Counting Tree Rings

Counting ring patterns on a cross-section of a tree trunk or branch will give a good indication of the age of the tree at the point where the rings are counted. Most children seem to enjoy this kind of activity.

Ring patterns on hardwood trees and slow-growing trees are going to be small and sometimes difficult for children to count. However, trees with soft wood such as poplar and most pines, have large growth rings which are easier to count. Generally, a tree adds one ring for each year of growth. In most trees each ring will be made up of a light and dark

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band. The light band will be the spring wood which grew in the spring of the growing season. The cells will be larger than those in the summer wood. The summer wood will usually be darker than the spring wood. New annual rings are added to the outside of previous rings. Since a tree will usually add only one ring each year (spring and summer band), a count of the number of rings will give an indication of the age of the tree at the point where the cross-cut was made. Since the bottom of a large tree's trunk is much older than the top-most part of the trunk, the bottom will have more rings. In a similar way, the larger part of a branch will be older than the small twigs on the end of the branch. The students will be able to discover for themselves that the smallest twigs will often represent one year's growth.

This tree is in it's 25th year

The tree ring activity might start with the children counting the rings from their plant puzzles. It could proceed to a class activity using a branch larger than any of those used so far in this unit. Perhaps one of the students' fathers is planning to cut a branch off of a tree in the family's yard. Or, perhaps the person in charge of landscaping the school ground is planning to trim back a tree. (This usually is done in the fall of the year during the dormant period.) In either case, it would be ideal if the students could all watch the limb being removed. Possibly a field trip could be arranged. Your local government's department of parks might set up a field trip like this. You could ask the person who cuts the limb to also cut it into 1-2 foot lengths.

The limb could then be taken back to the classroom. Have the students begin to observe it by looking at one of the smallest branches near the end. Suggest that they cut small branches off of the main branch at various intervals working from the end back toward the point where the limb was cut from the tree. They can check the number of rings on each branch and also the number of rings on each of the large cross-cuts of the main branch. If you have the students smooth the cross-cut off with sandpaper the rings may be easier to count.

After the students have made their observations and counted rings at various points, discuss with them any differences they found between the ages of branches and between the age of the larger part of the main trunk and the smaller part.

IV. Observing Buds

Another interesting comparative study would be for the children to see what the buds become. Buds on branches do not necessarily turn into leaves. A bud may turn into a twig full of leaves or it may turn into a flower. (Actually, a flower is a modified twig.) Some leaves turn into petals and sepals Buds from different plants turn into different-looking twigs and different-looking leaves. The flowers are particularly different on many plants. Those on elm, oak, birch, and maple are quite distinctive and quite surprising. Often the flowers will come before the leaves on many of the early blooming trees such as oak and elm.

Dear Parent:

Please help your child collect two branches, both from the same tree or bush. Cut branches that are as much alike as possible. They should be about as long as your child's arm. If they are branched they will be more interesting to study. Roll them in newspaper so they can be carried to school easily.

Your child also needs a quart milk carton. We need the branches and the carton for class on _____.

Thank you.

Dear Parent:

Please help your child collect two branches, both from the same tree or bush. Cut branches that are as much alike as possible. They should be about as long as your child's arm. If they are branched they will be more interesting to study. Roll them in newspaper so they can be carried to school easily.

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Your child also needs a quart milk carton. We need the branches and the carton for class on _____.

Thank you.

THE ENVIRONMENTAL UNITS

Below is a list of the twenty-four titles in the Environmental Discovery Series. Next to the titles, we have suggested the grades for which each is most appropriate. We emphasize that these are suggested grade levels. The teacher is encouraged to adapt the activities to a wide range of grade levels and subject areas depending upon the interests and abilities of the students.

Order No.	Title	Grade Level	Price	Order No.	Title	Grade Level	Price
79007	Plants in the Classroom	3-6	$1.50	79123	Genetic Variation	4-9	$1.50
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79105	Nature Hunt Spec. Ed.	K-1	1.00	79203	Stream Profiles	4-9	1.00
79098	Sampling Button Populations	3-9	1.00	79221	Color and Change	K-2	1.00
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